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E SOLVING SOLDERING HIERARCHY PROBLEMS BY METALLURGY AND DESIGN

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Packaging of semiconductor devices into a module which was soldered to a card, which then had connectors attached, used a hierarchy of solders with the highest melting point solder used for the first operation. Lower melting point solders were used for each subsequent operation so that the joints previously formed would not remelt in the later soldering processes [*]. For a complex product involving multichip interposers, surface mount devices pin grid array and edge connectors, and possibly optical cable connectors, the soldering hierarchy approach becomes extremely awkward. There may not be enough different solders with distinct melting points to make a reliable joint for each of the components.

The disclosed method utilizes a layered Pb/Sn structure and the metallurgical reaction occurring in the joining to accomplish a number of joining steps with a same peak process temperature. The metallurgical reaction raises the melting point of the solder after the initial low temperature joining so that the solder does not remelt during the following processes.

The advantages of the layered Pb/Sn solder are:

1. The same process is used for all levels of joining, so that a single process and set of equipment can be used for all levels of joints instead of several solder processes with different process temperatures.

2. The need for very high melting point solder for the first step is eliminated, so the stress on the product due to cooling from a high temperature solder process is eliminated, and lower temperature compatible materials can be used.

An example of joining two copper surfaces using a layered Pb/Sn solder is given to show how the process works: the first Cu surface to be bonded was coated with a thick layer of Pb or a high Pb solder with a melting point above 300^{o}C followed by a thin layer of Sn. The total weight ratio of Pb/Sn should be above 9 so that the structure, when homogenized, will not melt below 275^{o}C. The second Cu surface can be either: Cu coated identically as the first surface, a bare Cu surface, or a Cu surface coated with a thin layer of Au for enhancing wettability. The two surfaces are then brought into contact and heated up. During heating, Pb and Sn reacts to form Pb/Sn eutectic, which melts at 183^{o}C, on the surface, and the joining is achieved by the mixing of the liquid or the wetting of Cu or Cu/Au surface by liquid

solder. Dwell at a temperature above 183^{o}C results in the reaction between Pb/Sn eutectic and the excessive Pb. As a result, a homogenized Pb/Sn alloy, with a melting point above 183^{o}C, is formed and solidified. The melting point of the formed Pb/Sn alloy depends on the total ration of Pb/Sn initially coated on both surfaces but will typically be around 300^{o}C. The subsequent joining processes can be conducted using the same layered structure. The last joining step can use a simple Pb/Sn eutectic solder if no rework processes are necessary.

Reference

[*] D. P. Seraphim, R.C. Lasky and C.Y. Li, ed, Principles of Electronic Packaging, McGraw-Hill, New York, NY, 1989, p. 588.